NASA TECH BRIEF
NASA Pasadena Office

Transmitter Switch for High-Power Microwave Output

The problem:

Mechanically-operated waveguide switches are often used to combine the outputs of two transmitters to yield a high-power microwave output. The switches are relatively slow and are subject to wear. In addition, they cause energy losses which generate heat. The result is that klystrons can fail prematurely due to high heat stresses.

The solution:

A new high-power microwave switch has been developed which has no moving parts. The switch can combine the outputs of two 250-kW klystrons.

How it's done:

The switch is based on a four-port 90° hybrid junction, or combiner, as shown in Figure 1. The combiner is essentially two parallel waveguides connected by a coupling slot. When a signal is applied to port 1, a signal of one-half the power will appear at port 3 in phase and one-half the power will appear at port 4 advanced 90° in phase relative to the signal at port 1. When a second signal of the same power is applied at port 2, -90° out of phase with the signal at port 1, the two combine at port 3 with a total power almost equal to the sum of the signals at ports 1 and 2. A small component of output power at port 4 (typically 30 dB less than the power level at port 3) is a function of the unbalance in the hybrid.

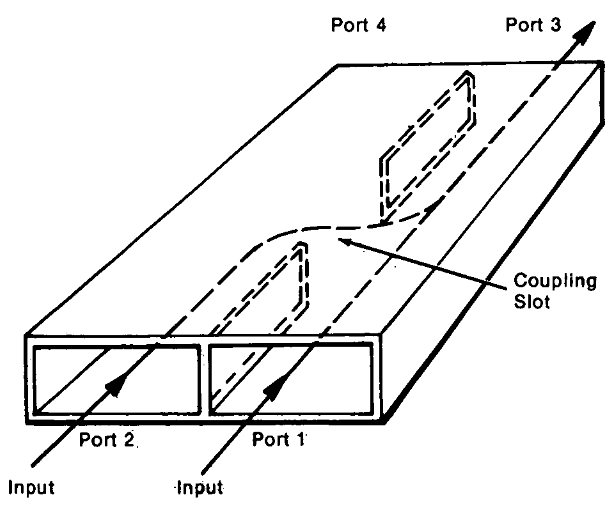

Figure 1. Simplified Diagram of Combiner

By changing the phase of the port 2 signal by ±90° with respect to the signal at port 1, the two combine so that most of the power output is at port 4 and the small residue is at port 3. Thus a ±90° biphase change in one input signal with respect to the other transfers the signal from one output port to the other.

A functional block diagram of the switch/combiner, 400-kW microwave system is shown in Figure 2. Two klystron power amplifiers feed the inputs into the 4-port combiner through two microwave switches, respectively. By switching the phase switch or modulator to ±90°, the output of the klystron amplifiers can be switched to port A or B.

From port A the microwave power is applied to the transmit/receive microwave switch for radiation from the antenna and the dissipation of the loss power (due to hybrid unbalance) from port B through the coupler. Power due to loss is dissipated through the microwave switches and power dividers into the RF loads. The power dividers connected to the RF loads split the power for dissipation into two loads each, since a total of 400 kW must be dissipated during initial phasing of the klystrons. A phase sensor and power monitor, together with phase control, provide closed-loop phase compensation for the carrier frequency and monitoring of the power level.

(continued overleaf)

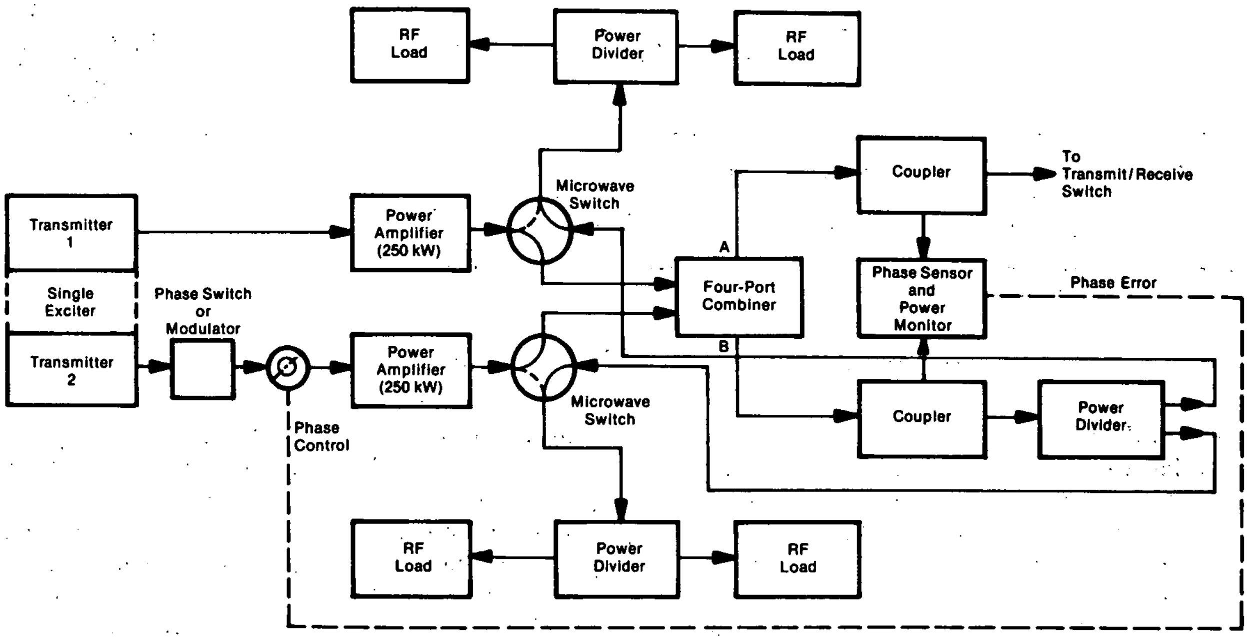

Figure 2. RF Power Switch and Combiner System

As mentioned previously, the power switch and combiner system can be used for combining the output powers of two transmitters or for switching from one to the other. This can be done when a pair of transmitters operate on the same frequency and the carriers are phase coherent as by excitation from a single exciter. The carrier source may be any combination of transmitters used in radar or communications. If calorimetric RF loads are used, the total transmitted power can be measured when the phase is selected so the output power is combined at port B of the combiner.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
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Reference: TSP75-10122

Patent status:

NASA has decided not to apply for a patent.

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